10 Eng. Hist. Topogr. vol. 19

OBSERVATIONS

ON

The LETTER by a BY-STANDER,

BRISTOL printed in the Year 1760.

To which is added, an

EXPLANATION

Of a certain METHOD of

Building a SINGLE-ARCH BRIDGE.

Humbly offered to the Gentlemen appointed Commiſſioners for
re-building a Stone Bridge in the City of Briſtol.

Illuſtrated with a COPPER-PLATE.

By FERDINANDO STRATFORD, *Engineer.*

> Studious he ſate, with all his books around,
> Sinking from thought to thought, a vaſt profound!
> Plung'd for his ſenſe, but found no bottom there;
> Then writ, and flounder'd on, in mere deſpair.
>
> POPE's DUNCIAD.

GLOCESTER: Printed in the Year 1762.

BRITISH MUSEUM

OBSERVATIONS

ON

The LETTER by a BY-STANDER.

SEEING two advertiſements in the Briſtol-Journal relating to Briſtol Bridge, the firſt inſerted the 6th and the ſecond the 20th of March 1762, and being named with others in the firſt advertiſement, a natural curioſity induced me to procure the pamphlet pointed at, intituled, *A Letter*, &c. *by a By-ſtander*, in order to examine the ſame; and having peruſed it, I find the anonymous letter-writer ſo free in his borrowed cenſure, and ſo void of impartiality, truth, and candour, that he is juſtly called in the advertiſement a Plagiary.

The By-ſtander begins his letter with obſerving *that the town and country too have been playing at a kind of puzzle, with relation to the figure and ſtrength of Arches*; but I cannot obſerve where he has unpuzzled the ſubject in the leaſt, notwithſtanding his Colloſſian inſtance of the navigation arch.

It is a matter of wonder that an author, neither verſed in the theory nor practice of hydraulic architecture, ſhould attempt to cenſure an art which he does not comprehend; and, inſtead of writing confuſedly and unintelligibly, he might, with more propriety, have pointed out ſimilar works in our own country, if only on account of the materials ſuch works are built with.

The art of Bridge-building in this age and in this kingdom has been executed with great ſkill, inſtanced in the bridges already erected, both on account of the internal conſtruction, elevations, and finiſhing in a good taſte.

The methods for ſecuring of foundations are ſufficiently known, let the ſubſtance of the natural foundation be what it will. There are ſome parts in the art of conſtructing bridges to be deduced from theory founded on mathematical demonſtrations, and thoſe parts which have been overlooked are equally capable of mathematical proof, and then the art of bridge-building will be complete.

I ſhall next ſhew that the By-ſtander's letter is a meer piratical tranſcript from an anonymous letter-writer, intitled, *Obſervations on Bridge-building, and the ſeveral plans offered for a new bridge at or near Black-friars.** But circumſtances relating to Black-friars bridge and Briſtol bridge are far from being ſimilar.

In juſtice to myſelf and the other gentlemen mentioned by the By-ſtander, I will point out the page from whence he ſtole his ſubject matter, and give the ſubſtance of it where neceſſary.

He begins his remarks with paying me the firſt compliment, as being the greater ſtranger, in theſe words, "*But I doubt whether he has ſucceeded as well in this firſt production of a compoſition in a ſtone bridge.*" † The By-ſtander is miſtaken here, the deſign he points at not being my firſt production of a compoſition in a ſtone bridge.

He then goes on, "*This deſign at firſt ſight ſtrikes me ſomething like looking at a turkey-carpet, &c.*" ‖ If the By-ſtander is pleaſed or diſpleaſed with the variety of colours in my plans he equally ſhews his ignorance,

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* London, printed and ſold by J. Townſend, at the corner of White-friars, in Fleet-ſtreet, 1760.

† See London obſervations, page 8, on Mr. Barnard.

‖ Page 21, on Mr. Gwyn.

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there being a ſtandard or mode in deſigning and drawing of aquatic and other architecture known and practiſed by foreign as well as Engliſh artiſts; for tho' a language may differ according to the country, yet drawings in the aquatic, military, and civil architecture, carry with them an univerſal ſtile known to artiſts who have had a regular education in thoſe ſciences. Then he goes on, "*He does not ſeem to know the ſhorteſt way to ſupport receſſes from the end of the piers, and for that reaſon has a deal of ruſtic work in form of octagonal turrets, &c.*" * The By-ſtander's cenſure of the ruſtic finiſhing to the piers proves his partiality and ignorance of the ſubject he treats of. The deſign for carrying up the piers, octagonally or in any other figure, is founded on true mechanical principles, as my late worthy friend Mr. *C. Labelye* has proved in the conſtruction of Weſtminſter bridge, being to preſerve an equilibrio or equal preſſure on all parts of the foundation of the piers. To condemn ruſtic finiſhing ſhews a want of taſte in aquatic buildings: York ſtairs, deſigned by *Inigo Jones* in that taſte, is admired: The right honourable the commiſſioners for building Weſtminſter bridge approved of this ſtile, and ſeveral of them were good judges in civil and military architecture, and bridge-building in particular. †

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* Page 9, on Mr Barnard.

† Mr. Labelye's account of that building.

Then the By-ſtander objects to the receſſes and octagonal ſemi-domes, but exactly in the words of the Obſervations, *&c.*[*] We ſee the uſefulneſs of receſſes and ſemi-domes on Weſtminſter bridge: The builders of Eſſex bridge, Dublin, thought them ſo, and finiſhed all their receſſes with ſemi-domes, tho' the arches are nearly of the ſame magnitude as in my deſign. The By-ſtander and his favourite author compare theſe dome-like finiſhings to a bathing-tub, and ſay the receſſes will preſerve a continual ſmell; nothing of which however happens on Weſtminſter bridge.

The next objection is againſt new foundations, which he gives to us from the words of the ſame author.[†] As to the buſineſs of ſecuring the foundations of bridges, *&c.* the moderns have ſufficient experience in ſuch works. The methods I have pointed out in the papers delivered to the commiſſioners at their meetings are fully ſufficient to ſupport the ſuperſtructure of my eliptical or ſemicircular three-arched bridge then propoſed. As to the proportions of the piers, water-way, and paſſage over the bridge, in my deſigns, they are adapted to the ſituation, and proportioned on juſt principles, which I am able to evince to any perſon.

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[*] Page 9, on Mr. Barnard.

[†] Page 14, on Mr. Chambers.

The By-ſtander diſlikes the modilions, and the cordon, or ruſtic corniſh; but his objections are ſtill in the ſame author's words.* The objection to modilions from *Vitruious* (I ſuppoſe they both mean *Vitruvious*) is low and trifling. The ſubſtance of what that ancient author has ſaid is, that modilions repreſent the ends of rafters, and in ſome caſes it may be true; yet you will find in the remains of antiquity, as well as in many elegant modern buildings, modilions in the cornice of the pediment, and at the foot of the attic ſtory even in the moſt ſuperb edifices: And, in thoſe ſituations, modilions cannot be ſaid to repreſent the ends of rafters. One reaſon for introducing the cordon or ruſtic corniſh in bridges is from its figure, which is ſimple and of large dimenſions. All cornice, in elevation of a large pile, are found to have the beſt effect when the members are few and of bold relievo; all connoiſſeurs agree in this. The pretence of its not carrying off the rain is not worthy notice; for the intention of a cornice in bridge-building is not ſo much to carry off rain as to add to the relievo of the elevation at a diſtance, and give the whole ſuperſtructure additional grace and beauty.

The By-ſtander, after making two or three more of his obſervations, tho' very inſignificant ones, is pleaſed to ſay the interior diſtribution

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* Page 13, on Mr. Chambers.

bution of my deſign is excellent and deſerves praiſe. As I have had no opportunity of examining the other plans for re-building Briſtol bridge, I can only point where the By-ſtander has borrowed from the London Obſervations, *&c.* his cenſure on Mr *Wood*,* and on Mr. *Tully*. †

Now Mr. By-ſtander introduces Mr. *Bridges*; and ſpeaking of his lofty ideas ſays, " *A bridge which has no relation to mode or faſhion, &c.*" in the words of the Obſervations, ‖ and makes uſe of the ſame words in praiſe of his idea of making it a repoſitory of the actions of our admirals, *&c.* Then remarking Mr. *Bridges*'s arch, he ſays *the cornice and baluſtrade of this bridge make, from one end to the other, a ſegment of a large circle.* You may find nearly the ſame is ſaid of Mr. *Mylne*'s deſign for Black-friars bridge. ‡ Now drawing near to a concluſion, I will mention what the author of the Obſervations, *&c.* ** claims as inventions peculiar to Mr. *Mylne*. viz.

' *All the methods which he propoſes for conſtructing of this bridge (Black-friars) are*

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[*] Pages 10 and 11, on Mr. Chambers, and page 16 and 17, on Mr. Dance.

[†] Pages 42 and 43, on Mr. Ware, and here are 24 lines intirely copied.

[‖] Page 25, on Mr. Mylne.

[‡] Page 26, on Mr. Mylne.

[**] Pages 29, 30, and 31, on Mr. Mylne.

‘ *ingenious, and ſhew a good mechanical head.* ‘ *That they are eaſy and ſimple you will be* ‘ *more able to judge from his own demonſtrations; but I beg leave to name a few* ‘ *wherein he goes beyond thoſe made at Weſtminſter bridge. The method of building the* ‘ *caiſſons, within high-water mark and yet* ‘ *above it, upon frames that fall to a level,* ‘ *where the ſides may be floated and fixt to* ‘ *them; the method of making the ſides of the* ‘ *caiſſon higher than high-water mark, and* ‘ *ſplitting them in the middle to be carried away* ‘ *after they have preſerved the pier dry from* ‘ *laying the firſt courſe of ſtone ’till it is at* ‘ *high-water mark; the method of ſupporting* ‘ *the centers from off-ſets in the ſides of the* ‘ *piers, and by that ſaving the piles and trying* ‘ *the piers; the improvement made on the center* ‘ *itſelf, and manner of joining and lowering* ‘ *of it; the method of conſtructing all the* ‘ *arches by three centers only, which is ſo* ‘ *ſimple that one is ſurpriſed it has not been* ‘ *found out before now; the method of founding* ‘ *the abuttments in caſes made of the old* ‘ *centers and ſides of the caiſſons; the method* ‘ *of joining the courſes of ſtone in the piers is* ‘ *a great improvement on that of the ingenious* ‘ *Mr.* Smeaton’s *invention for Eddyſtone lighthouſe: All theſe which I have been able to* ‘ *remember are ſo palpable that one is ſurpriſed* ‘ *and pleaſed at the ſame time.’*—Then goes on.—‘ *The form which he gives to the ends of* ‘ *the*

'*the piers, as the beſt for cutting the water, is,* '*I think, without doubt better than any other* '*hitherto made uſe of. It is made nearly like* '*the bow of a boat, and yet ſo as is conſiſtent* '*enough to be put in execution in ſtone; by* '*which means it is ſomething like Sir* Iſaac 'Newton's *irreſiſtible ſolid.*' I know of no ſuch ſolid; but Sir *Iſaac Newton* treats of a ſolid of the leaſt reſiſtance to move in water, and the ſolution and demonſtration of that problem is given by Mr. *Facio*, Mr. *Bernoulli*, and the Marquiſs *de l' Hoſpital*, and alſo in the *Lady's Diary.* The curves here meant make the ſaliant angle of the piers nearly of 60 degrees, and the French latterly terminate this angle by two cylindric ſurfaces whoſe baſes are arcs of 60 degrees, in all their new bridges.

Now you ſhall hear what the By-ſtander ſays for Mr. *Bridges.* † '*But you will be* '*more able to judge of this from his own* '*demonſtrations; tho' I beg leave to name a* '*few of his own ingenious inventions, that* '*have been overlooked by ninety-nine out of a* '*hundred, wherein he goes beyond any of his* '*cotemporaries. The method of building the* '*caiſſons is an improvement on that made uſe*

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† Pages 34, 35, and 36. By-ſtander.

‘ *of at Weſtminſter bridge, and ſplitting them* ‘ *in the middle to be floated away after they* ‘ *preſerve the pier dry from laying the foundation under water; the method of ſawing* ‘ *his piles off cloſe to the ground under water,* ‘ *whether the river be high or low, rapid or* ‘ *ſmooth, is curious; his method of ſupporting* ‘ *the centers from off-ſets in the ſides of the* ‘ *piers, and by that means ſaving a number* ‘ *of piles and trying his foundation; the improvement made on the center itſelf, and* ‘ *manner of joining and lowering of it; the* ‘ *manner of conſtructing his three arches with* ‘ *two centers only, which is ſo ſimple that I* ‘ *wonder it hath not been found out before* ‘ *now: All theſe which I have been able to* ‘ *remember* (ſurpriſing memory!) *are ſo* ‘ *palpable that one is ſurpriſed and pleaſed at* ‘ *the ſame time. The author I hope will pardon* ‘ *me, if I have forgot or miſrepreſented any of* ‘ *them.* (no doubt of it) *The form which he* ‘ *gives the ends of his piers, as the beſt for* ‘ *cutting the water, is, I think, without doubt* ‘ *better than any other hitherto made uſe of:* ‘ *It is made nearly like the bow of a boat, yet* ‘ *ſo as is conſiſtent enough to be put in execution* ‘ *in ſtone; by which means* (as he expreſſes it) ‘ *it is ſomething like Sir* Iſaac Newton's *irreſiſtible ſolid.*’ *N. B.* Weſtminſter bridge conſiſts of thirteen principal arches, and was conſtructed with eight centers only.

Upon

Upon the whole, the notorious partiality, and the ſo evident plagiariſms that appear throughout the whole of the By-ſtander's letter, make it too obvious that his pen was ſet in motion by no very honourable motive. I muſt confeſs too it appears not a little diverting to ſee a man enter the liſts as his own champion, and meanly to attempt ſupporting a character by profeſſedly *avoiding perſonal reflections*, when he intends dealing about ſo freely the moſt deſigning obloquy, that *ruſt of indiſcretion and ill manners*, when he cannot but be ſenſible how infinitely preferable is *the varniſh of civility and good-breeding*.

When I offered my firſt plan, I was actuated by no other motive than the honour of ſerving you; nor was I ever willing or deſirous to detract in the leaſt from any other gentleman's merit, tho' his plan might more fortunately be approved of.

As to my preſent ſcheme, ſhould I have omitted any particular that ought to have been taken notice of, or been too brief in any one circumſtance, I ſhall be ready to make any alteration that may in any degree appear for the better: But ſhould you think it, in general, worthy your approbation, my greateſt care ſhall be to merit your favour,

and

and to attempt acquitting myſelf as deſerving of that choice which your well-known candour may fix upon,

Your moſt obedient,

and moſt humble Servant,

FERD. STRATFORD.

AN
EXPLANATION
Of a certain METHOD for
Building a SINGLE-ARCH BRIDGE,
Founded on
PRACTICE and Mathematical DEMONSTRATION.

New *Methods* are not eaſy underſtood;
And few will ſtep in an untrodden road.
'Tis better to purſue the *Rule* that's known,
Than truſt to an *Invention* of your own.

Art. Archit.

AS I underſtand it is the ſenſe of the greateſt part of the city of Briſtol to approve of a Single-arch Bridge, but the methods already offered for building of it carry with them difficulties not ſufficiently anſwered, which is generally the caſe in propoſals of new methods not well eſtabliſhed from unerring examples; you'll be pleaſed to peruſe my method, herein after explained, for building a Single-arch Bridge on a ſolid foundation. I obſerve by the boreings, (procured under your directions) a variety of ſtratas of

matter

matter different in quality; and therefore any method but piling will be inadequate to a ſure and laſting foundation in caſe of a three-arch bridge, where the preſſure is leſs on the foundations by its being more divided. On the other hand, to attempt to ſupport the foundation of the abuttments of a ſingle-arch bridge in the ſame manner, may be ſubject to great difficulties and hazard, becauſe of the additional preſſure to be ſuſtained by two foundations only. A method has been propoſed to conſtruct the abuttments by ſmall portions of materials ſunk down at a time (or what is called cheſt-work.) This method carries with it an improbability of ſucceſs, as there is great uncertainty in that method of gaining a level baſis, after the earth, *&c.* is moved away from the face of the ſand-rock. Beſides this difficulty, there is another objection which engineers and workmen obſerve, which is, that the whole work, in that method of proceeding, will have no other bond to keep it together than its own weight; whereas the ſure rule of building piers or abuttments is firſt to make level the foundation according to the conſtruction of the building, and then by laying the ſtones courſe after courſe, with good bonding, and the whole well cemented and crampt together.

There are inſtances, 'tis true, where the cheſt-work method is made uſe of, but not for the

the ſupport of ſuch wide expanded arches. The inſtances I have met with of this ſort are uſed for laying the foundations of moles, dikes, or pier-heads for the ſecurity of harbours, and alſo in building fortifications in the ſea, &c. but in theſe inſtances the works are performed where the riſe of the tide is not ſo great, nor the water ſo turbid and foul, as to leave a ſediment on every ebb.

The method I will now point out for performing this deſirable work eſtabliſhes every idea of practicability in the execution, conveniency and utility in a bridge, elegance in the deſign, and certainty as to duration of the conſtruction.

The parallel breadth of the river a little above the hollow return of the wall above St. Nicholas's abuttment I find to be nearly 160 feet. A chord of this ſpan I propoſe for the ſingle-arch bridge at low-water mark. The land-breaſt or walls on each ſide of the river are now 26 feet high; the depth in the channel at the greateſt ſpring-tides 28 feet, and nearly 5 feet at low water.

The area of the ſection of the river will be - - - - - - 4480 feet
The area of the ſection of the old arches, or preſent water-way, is nearly - - - - - - - 2011 feet

The area of the ſection of this ſingle arch for water-paſſage will be - - - - - -	3350 feet
It appears that the opening of this ſingle new arch increaſes the area of the water-way by - -	1339 feet

From hence we are ſure of ſufficient improvement in that article.

The length of the curve of the arch will be 245 feet and 6 inches, and 120° 42′ of a circle.

The ſuffete of the crown of the arch ſhould be about 3 feet and 6 inches above the greateſt high-water mark, which will make a ſufficient head-way for the up-country veſſels paſſing thro' the bridge in the early part of the ebb. I recommend the foot-way to be made 7 feet wide, and the carriage-way 30 or 31 feet wide, to give a free paſſage on the bridge at the time of fairs or other public occaſions. The dimenſions of my deſign are ſuch as to procure all the favourable circumſtances that this ſituation will admit of; and as to the avenues to the bridge, that is a ſubject of mature conſideration for the commiſſioners, while the works more immediately belonging to building the arch are carrying on. And there will be no difficulty in fixing them properly from an accurate plan and level, to

aſcertain

aſcertain the true ſection of the ſtreets adjacent to the new bridge. The ſame method was uſed at the time of building Weſtminſter bridge.

I propoſe the great arch not to ſpring from unconnected artificial abuttments, but to be founded and ſpring immediately from the ſand-rock, underneath the ſeveral ſtratas below the bed of the river; a method which takes off all objection to lateral preſſure, or inſufficiency in artificial abuttments. Beſides, it will ſave a great expence in materials, which unavoidably muſt be made uſe of for that purpoſe, if the ſingle arch was to ſpring only from low-water mark. The real chord, or ſpan of the arch, will be increaſed and extend between its ſpringers 202 feet and 6 inches. This produces a great advantage on the Redclift ſide; for the lower part of the haunſe of that end of the arch may be brought up to low-water mark with leſs expence of batterdeau or coffer-dam, as this part of the arch may be built within-ſide of the preſent abuttment in the firm land. But laying the ſpringers, and bringing up the haunſes of the arch on St. *Nicholas's* ſide, will be more expenſive, becauſe there muſt be curved batterdeaux fences to connect St. *Nicholas's* old pier to the ſhore. The difficulties of making a pen by a batterdeau fence, to lay the ſpringers and lower haunſes of the arch, lie in ſecuring the foundation of it; but the methods I have known practiſed by the late capt. *Perry*, engineer, (who by dove-tailed piles has made batterdeaux and dams capable to pen the water 35 feet deep, and often have been drove from 15 to 20 feet or more into the bed of the river) will anſwer every objection. The method is thus:---Fir piles are to be properly dove-tailed to fit into the ſides of each other, of ſufficient thickneſs and length to reach the ſtrata of clay next the ſand-rock. They are to be drove in a curved line, and extending thro' the wall into the ſhore at each end, and alſo round the old pier; the heads of them to reach only about a foot above low-water mark. That will prevent the water from ouzeing from the river-ſide between the ſtratas in the bed of the river. It is well known water ſeldom riſes or ſinks perpendicular thro' the ſtratas, be it clay or earth of a ſufficient conſiſtency to hold water. Another row of ſtrong ſquare piles are to be drove, one line within-ſide, and another without-ſide of the ſheeting or line of dove-tailed piles, but at ſuch a diſtance from them as to contain a clay-wall capable to bear out the tide-water. The top of theſe piles is ſecured and tied together with proper plates or whale-pieces and croſs-ties. The looſe, gravelly, or upper matter in the bed of the river is to be ballanced out, and the whole ſpace between the ſquare piles is to be well filled with good rammed clay (the part of the batterdeau under low-water mark may eaſily be ſecurely rammed). In ſuch manner I propoſe to ſecure and fence the excavation pit for laying St. *Nicholas*'s end of the arch 'till it is raiſed up to low-water mark. The ſame method may be practiſed at the other end of the arch, but with leſs expence of batterdeau, becauſe the ſame piles may be uſed there. The excavations may be made intirely out of the reach of the tide-water, either from above or below the bed of the river; and when the lower haunſes of the arch are brought up to low-water mark, the batterdeaux may be taken up for the further uſe of piling underneath the land-breaſts or ſhore-walls, and alſo for making the upper centers for turning the remainder of the arch. By this means the pile timber will anſwer for ſeveral purpoſes, and will be a great ſaving in that article only. The remainder of the work above low-water mark will be common tide work, and not ſubject to any difficulty, if properly carried on.

This ſhort account of a method for laying the foundation of the intended bridge will give you ſome idea of the manner propoſed for doing of that work: And ſhould it appear deſerving your attention, I will explain more particularly the gradual ſteps to be taken therein by drawings and other means, demonſtrating the juſtneſs of my plan, and the practicability of executing the ſame.

From my calculations it appears that the arch ſimply conſidered, when the voiſſours are in equilibrio as deſcribed in the ſection, will require 11,190 tons of ſand ſtone, (tho' there is no neceſſity of its being conſtructed of one kind of ſtone, as a thinner ſort may do for the back of the arch) and an arch of the ſame ſpan and plumb to ſpring from low-water mark only, including the lower and upper abuttments, will require 15,147 tons, which is a great deal more than the former quantity; a circumſtance of great moment, and worthy conſideration.

By the ſame manner of calculation Mr. *Bridges*'s Arch, of 141 feet 6 inches' ſpan and 31 feet 4 inches' plumb, will require 13,763 tons of ſtone; but if the ſpringers were to be founded on the rock, according to my method, this arch will require only 9,790 tons, and conſequently is preferable on account of ſaving 3,973 tons of ſtone in building ſuch arch only.

I have annexed a plate with the elevation, plan, and ſection of my deſign for a Single-arch Bridge. The ſize of the plate admits of but a ſmall ſcale, yet the plans are drawn deſcriptive and eaſy to be underſtood.

In this ſhort account of a method of conſtructing the intended new bridge on a ſolid foundation, I have omitted the deſcription and manner of framing and fixing the lower and upper centers, and alſo the practical methods to be uſed in bringing up the work to low-water mark, and the ſeveral other ſteps neceſſary for your information. And as the old houſes are cleared away, the whole ground and ſituation may be re-examined, and accurate meaſures and levels may now more conveniently be made and taken thereof.

The DISTRIBUTION *of the Materials, and Sorts thereof.*

The two fronts of the archivolt, or platband of the arch, Ruar-deane ſtone; being a ſtone of a ſtiffer nature and fitter for that purpoſe, above low-water mark, than the ſand ſtone. The intermediate part of the arch, the Courtfield or ſand ſtone.

The ſecondary arch, any ſort of ſtone that riſes of a large ſize, tho' of a thin bed, will anſwer for that purpoſe.

The front ſpandrels, a ſort of ſtone about Blakeney ſide of the foreſt; being rather of a darker colour than Ruar-deane ſtone.

The internal ſpandrels to be filled up with rubble ſtone-work, laid in a particular manner to eaſe the preſſure on the haunſes of the arch.

The ruſtic cornice and lower plinth of the balluſtrade, Courtfield ſtone.

The upper plinth, balluſters, and top rail, Painſwick ſtone; which works pleaſant, hardens in the air, and ſtands the weather equal to any ſtone I have ſeen, when uſed above ground.

The borders to the foot-way, the Abby Gritt; this ſtone will not wear by the rubbing of the carriages from its cloſe ſtiff texture.

The foot-way paving, the ſtrong red Foreſt ſtone.

I propoſe all the work in the arch to be ſet and grouted in Aberthaw-lime mortar, becauſe mortar made of Aberthaw ſtone-lime will harden above as well as under water, and bind and unite the whole building together as if built with one ſtone.

N. B. In caſe the ſingle-arch deſign ſhould be executed, it will be proper to let part of the old piers ſtand, as it will ſtrengthen the batterdeau at St. *Nicholas*'s abuttment, and alſo will be a means of conſtructing the centers with leſs timber and leſs expence in framing and ſetting them up.

The END.

GR III

EXPLANATION of the PLATE.

Fig. I. The elevation of the arch and balluſtrade.

AB the ſection of the land-breaſts

*** The dotted lines ſhew the extent of the lower part of the arch, ſpandrel walls, and the face of the ſand-rock

Fig. II. The plan of the foundation of the arch and batterdeaux.

ABCD and EFGH the foundations of the ſpringers of the ſingle arch

IK and LM the dove-tail piles, a foot only above low-water mark

NOP and Q the ſtrong ſquare of fence piles

RS and TV the rammed clay

W and X the plan of the land-breaſts

Fig. III. The ſection of the batterdeau.

1 Croſs-tie

2 2 2 2 Plates or whale-pieces

3 3 Square fence piles

4 Dove-tail piles

5 Rammed clay

6 Firſt ſtrata, being mud, looſe gravel, and oyſter-ſhells

7 Second, ſtiff blue clay

8 Third, looſe ſand mixed with water

9 Fourth, looſe dry ſand

10 Fifth, red ſtiff clay mixed with ſmall ſtones

11 Sixth, the ſandy rock

Fig. IV. A ſection of the ſingle arch, and ſtratas above the ſand-rock.

A A, *&c.* the vouſſiors or arch ſtones, 6 feet long and 3 feet bed; and the intermediate only 4 feet long, and the ſame in the ſofit; the former will have a backing of 1 inch 3 quarters and 1 eight, the latter 1 inch and 2 eights

B B the ſecondary arch to preſerve an equilibrio in the vouſſiors

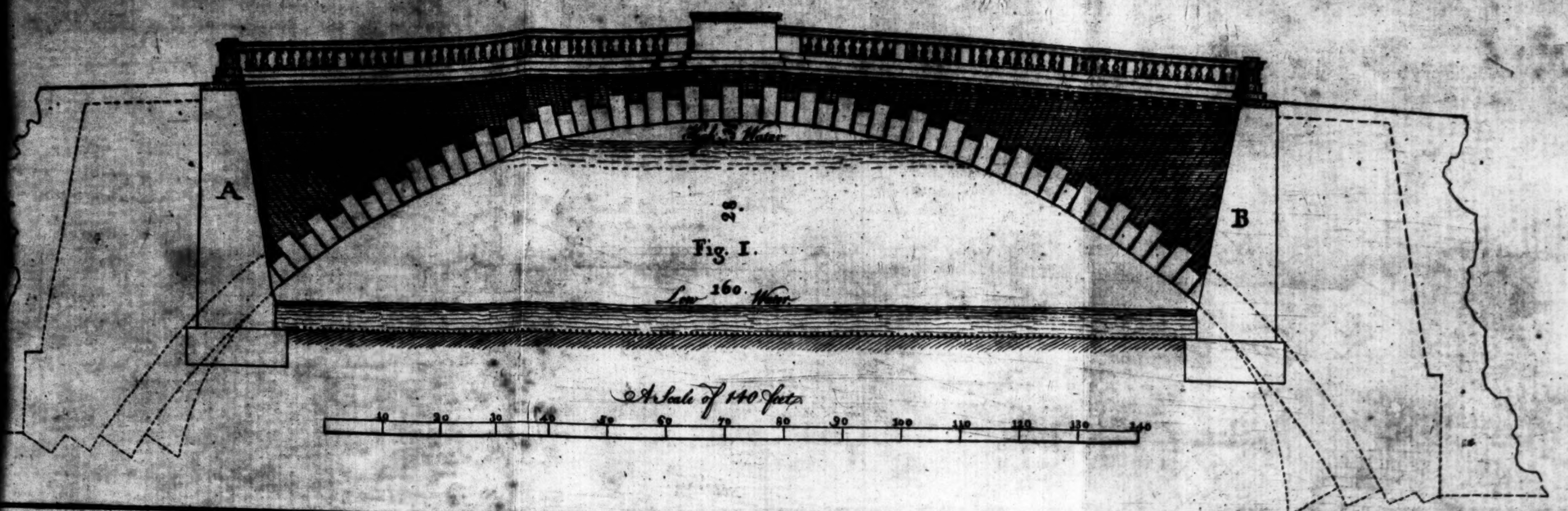
C C the back of the ſpandrel walls

D D ſection of land-breaſt counter arches

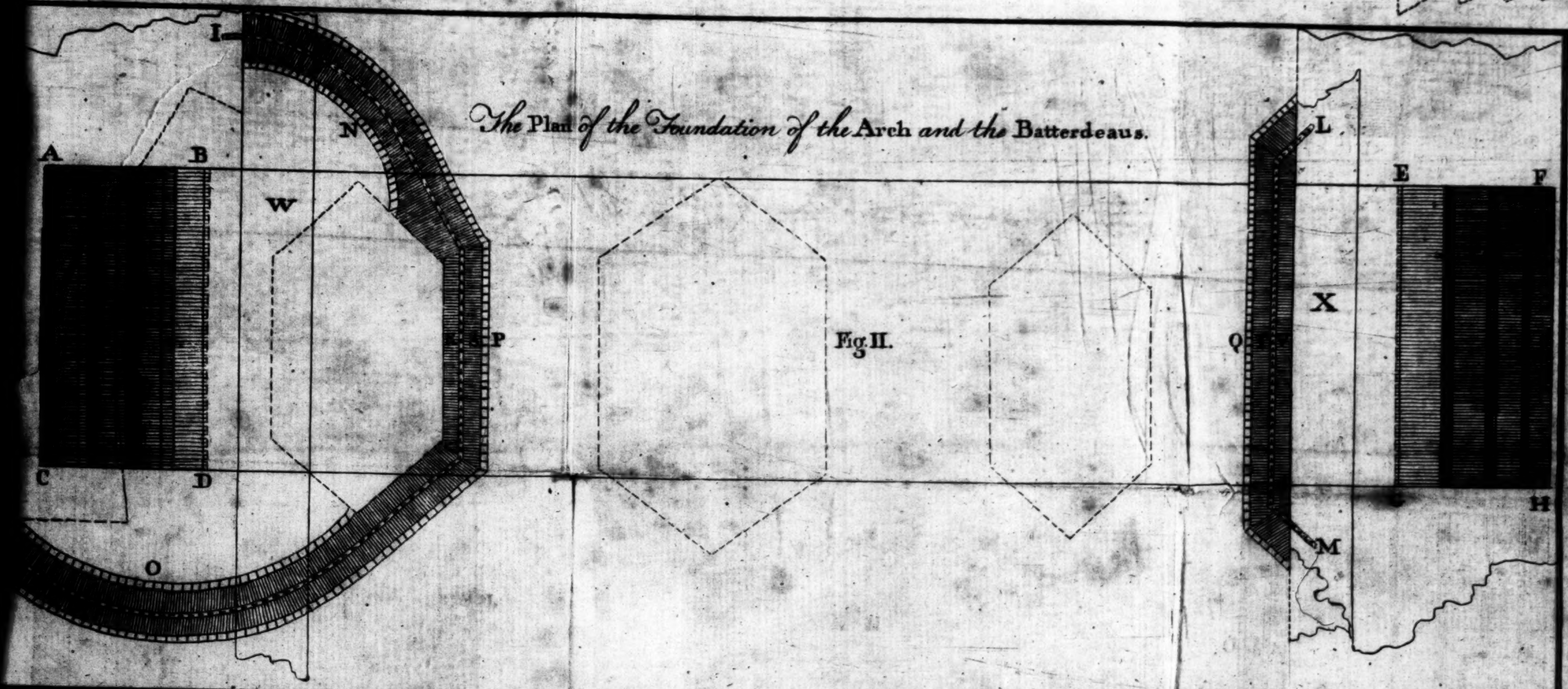
E E drains to carry off the water ſoaking through the pitching

F F paving to carry the water over the extradoſſe of the arch

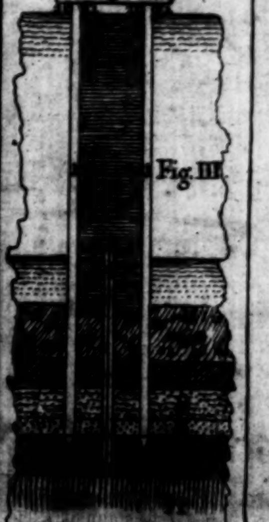
The Elevation of a single Arch-bridge, and Section of the Land-breasts.



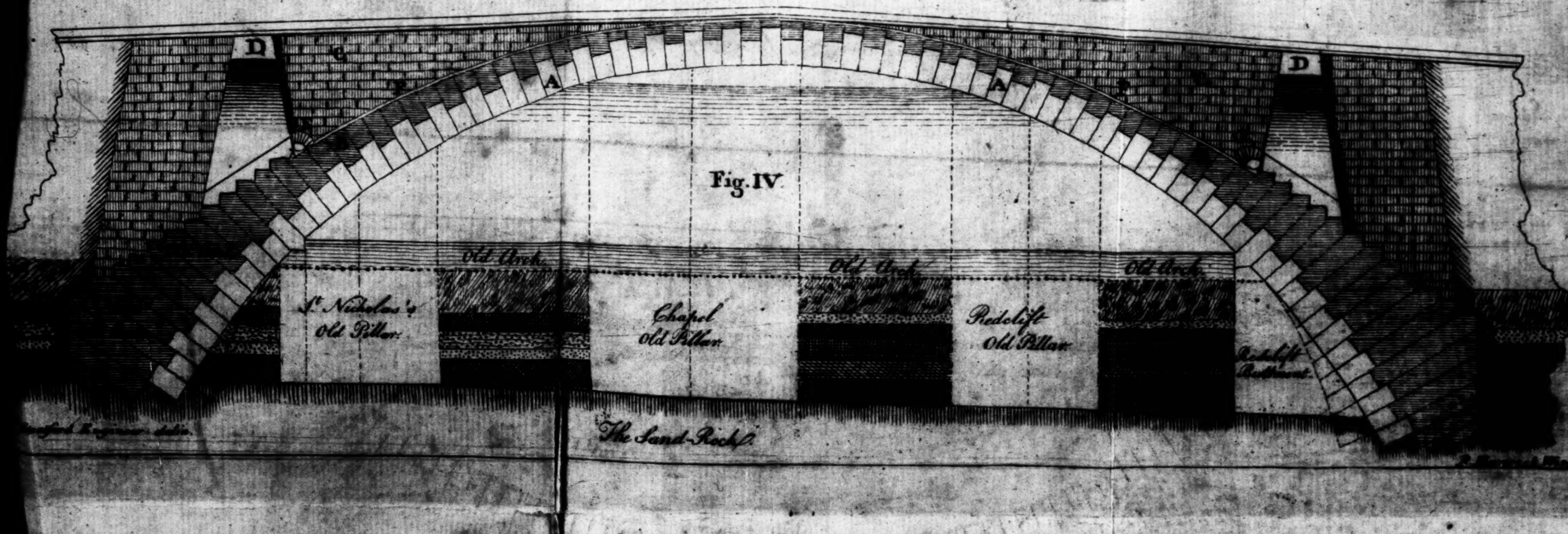
The Plan of the Foundation of the Arch and the Batterdeaus.



A Section of the Batterdeau Fence.



A Section of the single Arch and Stratas above the Sand-Rock.



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